industry, and the role of conservation education (the niche of this book) and a review of Polynesian cultural values that are stimulating new assessments of the island environment.

Culliney's *Islands in a Far Sea* is more a substantial narrative than a resource book. Chapters focus on Hawaiian ecosystems (marine, lowland, freshwater, montane) and associated biota; evolutionary history, ecology, history of human impacts, and current status are explored in language suitable for the non-scientist but with enough rich detail to satisfy a biologist. References from the scientific literature are thorough, current, and well chosen.

Both books survey the unparalleled diversity of Hawaiian life, from the well known (the spectacular radiations of endemic honeycreepers, tree snails, lobelioid forest plants, and drosophilid flies) to the obscure (the small fish and invertebrates climbing thousands of feet up rushing streams and waterfalls to breed in fresh water, or the endemic insects of lava tubes, recently evolved from surface forms). Both also tell of the overwhelming impact of European colonization and exploitation; the frontier-conquering spirit that devastated Laysan Island, for example, has the resonance of a Wild West setting. More surprising is the evidence of massive ecological disruption by the Polynesians—agricultural clearing, huge irrigation works, and the relentless killing of native birds for feathers all refute the idea of a gentle people living in perfect harmony with a benign environment.

Even more saddening are the examples of the destruction of native biota during a period (1960 to the present) when Hawaii's uniqueness has been well understood and conservation has been of public concern. Culliney saves his harshest words for developers and state agencies who are making decisions with irreparable consequences. For example, the importation of non-native ungulates and their maintenance as a game resource in vulnerable native forests has been allowed or even encouraged by state agencies, despite direct conflict with critically endangered forest birds and high-elevation plants. Recent development of coastal resorts has destroyed a major fraction of known anchialine systems, brackish pools supporting a fragile and unique community of invertebrates, only recently described and not yet well understood. Similarly, astronomical and other activity on Mauna Kea's summit is destroying another unique and scarcely known ecosystem; a complex group of invertebrates survives there as aeolian scavengers on whatever insects are blown to the summit from lower elevations. The primary threats to Hawaiian nature (habitat destruction, introduced diseases, non-native predators and grazers) are dealt with thoroughly.

The long-billed iiwi and a flower of ohia lehua. [From *Hawaii: The Islands of Life*; photo, David S. Boyton]

Scientific expertise is badly needed to provide a basis for conservation decisions. The entire genus *Achatinella*, comprising the diverse tree snails of Oahu, has been listed federally as endangered for seven years; at least half the species are extinct and the others are succumbing to an introduced carnivorous snail, but no recovery plan has yet been written. Similarly, huge efforts are dedicated to captive propagation and releases of the Hawaiian goose, the nene, but there is no understanding of why released birds fail to reproduce.

The third book, *Islands of Life*, was produced by the Nature Conservancy, with proceeds to go toward land preservation in the islands. The title refers both to the archipelago and to the preserves or fragments of natural areas painstakingly acquired—or yet to be established. The text is brief and is lyrical rather than technical—only Hawaiian or common names are used, and the threats to Hawaii are mentioned rather than dwelt upon. The photography is a stunning evocation of the beauty of native Hawaiian landscapes and life forms. It is certain to create a desire to see firsthand these places and unique beings; the loving photography of pristine Hawaii, however, will not prepare first-time visitors for the unlikelihood of seeing native birds or native forest without deliberate effort to get away from tourist locations.

Hawaii's story is a melancholy one, of finite island ecosystems and the irrevocable damage caused by introduced predators, plants, and disturbance; of the loss of the chance to study evolutionary patterns richer than those of the Galapagos; and worst, of the replacement of the unique by the weedy, so that a visit to Oahu might be a visit to any densely populated tropical area—Bermuda, Mexico, Asia. The message of these books is not defeatist, but a call for acknowledgment and preservation of what remains of Hawaii's uniqueness. Those who call for halts to tropical deforestation or who desire to contribute to the scientific basis of conservation efforts might do well to focus their expertise on the Hawaiian biota, whose evolutionary complexity is unrivaled and whose plight is as desperate as that of any tropical assemblage.

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A Cladisticization

Phylogenetic Relationships of the Lizard Families. Essays Commemorating Charles L. Camp. RICHARD ESTES and GREGORY PREGILL, Eds. Stanford University Press, Stanford, CA, 1988. xvi, 631 pp., illus. $80. Based on a symposium, Knoxville, TN, Dec. 1982.

One of the greatest scientific enterprises is the attempt to understand how the biosphere came to be as it is. To pursue this goal, we need to know how organisms, both previous and present, are genealogically related to each other. Such a map of the past, even if incomplete and not entirely accurate, is essential if we are to consider such questions as whether there are regularities in the way things evolve and, if so, what factors have been responsible for restricting change to produce such patterns. Attempts to develop such schemes of relationship—phylogenies—have been made since the appearance of the *Origin of Species* but fell from favor in English-speaking countries about 60 years ago. Renewed interest came with the 1966 translation of Willi Hennig's *Phylogenetic Systematics*. This was a much-expanded version of a book originally published in 1950. In fact some of the ideas that this second edition contained were already available in English. For instance, Paul Maslin had discussed how to recognize primitive and derived states of taxonomic characters in 1952. But it is an oddity of intellectual advance that a long, obscure text, preferably translated from another language, often has proportionally more effect than concise and lucid accounts.

Hennig's methods, which were subse-

quently called cladistics, slowly gained ground, but in the late 1970s the suggestion was made that evolution was not necessarily relevant to the process. The subsequent arguments were suprisingly ill-natured. Worse still, philosophers of science started to glide in, pausing only to fold their wings before hopping determinedly toward the increasingly bloodied opponents. Things began to look bad. Fortunately many workers simply stole away from the debate, taking Hennig's basic message, that shared derived characters can be used in principle to reconstruct phylogenies, and went to work. This resulted in a whole series of attempts to chart the past. The present volume is a compendium of such efforts devoted to the lizards. Well produced and illustrated, it is based on a 1982 symposium organized by S. Moody and dedicated to Charles L. Camp, who had produced a seminal phylogenetic classification of lizards in 1923. Like the cladistic method itself, the book seems to have had an eventful and prolonged gestation, taking nearly six years to appear. Of the 12 original speakers only six have contributed to the volume, although another two authors, and two obviously hard-working editors, have been coopted on the way. This strenuous history probably accounts for a coverage rather different from that suggested by the title of the symposium, which has been retained for the book: only two of its chapters deal directly with the interrelationships of the families of lizards. Nevertheless, all the contributions are relevant and their quality is almost uniformly good.

Late Paleozoic and Mesozoic lepidosauromorphs are discussed in relation to lizard ancestry (R. L. Carroll), and the phylogeny of the whole of the Lepidosauromorpha is dealt with on the basis of 171 characters (J. Gauthier, R. Estes, and K. de Queiroz). The same authors (in different order of precedence) also tackle the relationships among the 17 extant families of lizards and their affinities with snakes and amphisbaenians. Based on 148 characters, this key chapter gives a good overview of the problem and sets up a firm framework for future work. On the basis of the evidence presented here, snakes and amphisbaenians seem to be derived from the scincomorph-anguimorph lizards, but their precise relationships are not clear. An independent approach (W. Presch), concentrating on the Scincomorpha but including most other lizard families, produces rather similar results to those of the previous study but also distinct differences. These probably arise because, although large, the data set is less comprehensive in number both of taxa and of characters (91 used).

A study of the Iguanidae (R. Etheridge and K. de Queiroz) shows there are eight main groups, although their relationships are unclear and it is not even certain that they comprise all the descendants of a single ancestor. Relationships within each group are worked out in some detail. This is important not only because iguanids are a large family of nearly 600 species and are the dominant lizard group in North America but also because they have been used so much as ecological models and in evolutionary speculation, which are both areas that benefit from a phylogenetic perspective. By comparison a study of the just 22 species of eublepharid geckoes (L. L. Grismer) might seem like a vignette, but the analysis is very full and the biogeography of the group is also included. This suggests that eublepharids arose in Asia and dispersed in the early Cenozoic into North America and later into Africa, a pattern shared with some other lizard families.

Because of their explicitness, cladistic approaches to relationship have the advantage of making clear what it is we do not know. Areas of doubt, where relationships are undetermined, stimulate a search for new characters that may elucidate these uncertainties. In such searches, aspects of the organisms concerned, usually morphological ones, are surveyed right across the group under study. This may solve the problem, although there is a frustrating tendency for new characters to reinforce the parts of a phylogeny of which we are already reasonably sure without clarifying the sections of which we are not. Even here, however, there are consolations. Classically, comparative anatomy has tended to concentrate on a restricted number of types. In contrast, the analysis necessary for phylogenetic reconstruction involves comparison of numerous forms, sometimes all the species in a group. This gives a radically different perspective. For a start we get a real idea of the range of morphological transformations possible. Again, while the organ system under investigation may throw light on phylogeny, it may itself be illuminated by what we already know about phylogeny from other characters. The organ system can thus be put in a historical perspective so that some conception can be gained of what its original condition was and in what order changes took place. We can also assess its stability and get a minimum estimate of the number of times features have developed in parallel and whether they have been subsequently lost.

In the present volume, this approach has produced detailed and painstaking chapters on the tongue (K. Schwenk) and limb muscles (A. P. Russell). The lizard tongue turns out to reflect pretty faithfully the phylogeny derived from a wide range of other characters. In contrast, limb muscles appear to be riddled with homoplasy (parallelisms and reversals), so that they contribute little to overall analysis. Russell's chapter is a reappraisal of Sukhanov's work published in 1961 and demonstrates how much proper sampling of taxa and attention to polarity determination can alter interpretation of an organ system.

Taken over all, this book is a worthy tribute to Camp. As with his own publication on lizard relationships, working copies will undoubtably get that final accolade of utility, a battered and well-thumbed appearance.

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Fossils Demystified

The Conodonta. Morphology, Paleoecology, and Evolutionary History of a Long-Extinct Animal Phylum. WALTER C. SWEET. Clarendon (Oxford University Press), New York, 1988. x, 212 pp., illus. $65. Oxford Monographs on Geology and Geophysics, vol. 10.

When impressions of conodont body fossils were discovered in 340-million-year-old Scottish rocks several years ago, much of the mystery that had surrounded these fossils for almost 150 years was resolved. Before 1982, what was known concerning conodonts was based entirely on their microscopic toothlike elements, of enormous importance in solving geologic problems but of less help in identifying the nature of the animal that bore them. What were widely acknowledged to be the most enigmatic of fossils (assigned alternately to chordates, plants, and most of the invertebrate phyla) were finally identified from body impressions and determined to be "conodonts." With short wormlike bodies, bilobed heads, and a posterior fin, conodonts represented a phylum extinct for 200 million years.

Now, some seven years after the discovery, Walter Sweet removes more of the mystery in a splendid volume that forever elevates conodonts and their taxonomy from the "nuts and bolts" categorization of G. G. Simpson to respectable science. This synthesis of earlier work with the latest research substantiates that conodonts were among the most interesting of nature's great experiments. The heart of the volume is a refined classification of the major conodont groups. This includes recognition of two classes, possibly polyphyletic, the Cavidonti (new), a mostly coniform group with one to five elements per apparatus but no element in